CHAPTER 1 FERMILAB RADIOLOGICAL CONTROL PROGRAM

Revision History

Author	Description of Change	Revision Date
J. D. Cossairt	1. Reformulated in light of Fermilab-wide ESH&Q reorganization. 2. Modernization of Article 1 to reflect current practices 3. Editorial corrections as needed.	July 2015
J. D. Cossairt	1. Redefine appointment of the Senior Radiation Safety Officer (SRSO). 2. Correct references to FESHM chapters that are now incorrect. 3. Correct references to ES&H Section to reference the ESH&Q Section. 4. Editorial changes applied as needed.	September 2014
J. D. Cossairt	Most recent version issued prior to the institution of revision history tracking.	September 2013

CHAPTER 1 FERMILAB RADIOLOGICAL CONTROL PROGRAM

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PART 1 FERMILAB RADIOLOGICAL CONTROL MANUAL (SITE-SPECIFIC RADIOLOGICAL CONTROL MANUAL)

111 Radiological Control Policy

The Department of Energy (DOE) has given Fermilab senior management the responsibility of ensuring that DOE activities conducted on site comply with current regulations and standards. These include those activities that manage radiation and radioactive materials and that may potentially result in radiation exposure to workers, the public and the environment.

The Director of Fermilab continues to endorse the Laboratory's policies on the control of ionizing radiation as set forth in this Fermilab Radiological Control Manual (FRCM), a part of the Fermilab Environment, Safety, and Health Manual (FESHM):

> **An important objective at the Fermi National Accelerator Laboratory is to do our research in a manner such that the safety of personnel and the protection of the environment receives the highest consideration while at the same time we pursue excellence in the use of our Laboratory facilities. The procedures and restrictions in this Fermilab Radiological Control Manual have been carefully chosen to attain these goals in the context of the Laboratory's program of Integrated Safety Management.**
>
> **All Laboratory employees, users, and subcontractor personnel are expected to adhere to our environment, safety and health policies. These general policies are stated in the Fermilab Environment, Safety and Health Manual of which the Fermilab Radiological Control Manual is an important part. Non-cooperation or flagrant disregard of environment, safety and health procedures will be cause for disciplinary action or for denial of the use of Fermilab facilities.**

Nigel S. Lockyer
July 2014

Fermilab has, for many years, implemented the following radiological control policy developed to address the radiological control program pertinent to the operation and development of a high-energy research accelerator:

1. Particles shall be accelerated only when there are approved scientific, technological or medical uses for them.

2. No individual shall be exposed to radiation unnecessarily.

3. Radiation doses to individuals shall be limited to those maximum permissible doses set by the Federal Government through the DOE and at all times as low as reasonably achievable (ALARA).

4. The radiation levels at offsite areas and on site areas open to the public, as well as in general offices, shall not be greater than the limits set by the Federal Government through the Department of Energy and at all times maintained ALARA.

5. The beam absorbers, accelerator, and external beam enclosures shall be so designed that normal radioactivation of the soil, taking into account known hydrology of the site and foreseeable rainfall will not contaminate water leaving the site above the permissible levels set by Federal, State and Local Governments and in accordance with the ALARA principle.

6. Beam losses shall be limited by engineered and administrative controls so that the residual dose rate inside the accelerator and beamline enclosures shall safely permit all necessary maintenance in accordance with the ALARA principle.

7. Radiation shielding of the accelerator complex and beamlines is to be stringently controlled in accordance with good configuration management practices and the approved Safety Assessment Documents inclusive of the Shielding Assessment.

8. Individuals in the Laboratory are responsible for environment, safety and health (ES&H) aspects of activities under their supervision, including those related to radiation protection.

9. It is the policy of Fermilab that exposures to unborn children as a result of occupational exposure to declared pregnant radiation workers (See Article 951, *Prenatal Policy and Procedures*) shall be maintained ALARA.

10. Fermilab activities conducted outside of the United States on territory under the jurisdiction of a foreign government are subject to the radiation protection requirements of the host government.

112 Radiation Protection Program

To ensure that Fermilab's Radiological Control Program is of the highest quality, the DOE requires that DOE activities shall be conducted in compliance with an approved documented Radiation Protection Program plan (RPP). The DOE reserves the right to direct or make modifications to the RPP in accordance with the provisions of the contract between DOE and Fermi Research Alliance (FRA).

1. The content of each RPP shall be commensurate with the nature of the activities performed and shall include formal plans and measures for applying the ALARA process to occupational exposures.

2. The RPP shall specify the existing and/or anticipated operational tasks that are intended to be within the scope of the RPP. Any task outside the scope of the RPP shall not be initiated until an update of the RPP is approved by DOE unless the changes to the RPP do not decrease its effectiveness or affect compliance with any regulation (see paragraph 5 of this Article).

3. The content of the RPP shall address, but not necessarily be limited to, each requirement in 10 Code of Federal Regulations 835, *Occupational Radiation Protection* (10 CFR 835). The RPP shall include plans, schedules, and other measures for achieving and maintaining compliance with the regulations.

4. Updates of the RPP shall be submitted to DOE:

    a. whenever a change or addition is made;

    b. prior to initiation of a task not within the scope of the RPP; or

    c. within 180 days of the effective date of any modifications to the regulations.

5. Changes, additions or other updates to the RPP may become effective without prior DOE approval only if:

    a. the changes do not decrease the effectiveness of the RPP, as determined by the Senior Radiation Safety Officer (SRSO);

    b. the RPP, as changed, continues to meet the requirements as set forth in the regulations.

    Proposed changes that decrease the effectiveness of the RPP shall not be implemented without submittal to, and approval by, DOE.

6. Updates to the RPP shall be considered approved 180 days after its submission unless rejected by DOE at an earlier date.

113 Manual Applicability and Control

This FRCM establishes practices for the conduct of radiological control activities at the Fermi National Accelerator Laboratory. It states Fermilab's positions and views on the best courses of action currently available in the area of radiological controls.

1. This FRCM has been endorsed above by the Fermilab Director, the contractor senior site executive. It is considered to be part of the FESHM and thus conforms to all other documented safety plans required under the DOE-FRA contract. This Manual is a living document. It will be revised as required to reflect regulatory requirements and "lessons learned" at Fermilab and other large particle accelerators worldwide.

2. This Manual shall be kept current and is a controlled document maintained by the Environment, Safety, Health and Quality Section, (ESH&Q) in accordance with FESHM Chapter 1050. *Environment, Safety and Health Manual Procedures*.

114 Compliance

1. It is intended that a graded approach be used in applying this Manual. Throughout this Manual, the words "shall" and "should" are used to clarify which actions need to be done to meet the requirements of this Manual. The word "shall" is used to denote mandatory actions that must be performed. The word "should" is used to indicate a recommendation or best management practice. In this context, "shall" statements are requirements, but "should" statements represent guidance as to the preferred practice.

   The assumption underlying a graded approach to implementation is that it is not always feasible, economical, or indeed, in some cases, advisable to implement every recommendation of the Manual in all situations throughout Fermilab. A diversity of activities and experiments take place at Fermilab, and an action which makes sense in one situation is not necessarily a good idea in another. Many of Fermilab's activities are unique by their very nature and might call for special interpretations of the provisions of this Manual.

   The graded approach is a process by which the level of analysis, documentation, and actions necessary to comply with the Manual are commensurate with the following:

   a. The relative importance to safety

   b. The magnitude of any hazard involved

c. The life cycle of a facility

d. The programmatic mission of a facility

e. The particular characteristics of a facility

f. Any other relevant factor.

Consideration of these factors will allow the implementing division/section/center to focus resources on those activities most likely to reduce the associated risks and hazards.

2. It is important not to confuse the graded approach with exemptions from the requirements of 10 CFR 835 or other applicable requirements expressed in the FESHM and Director's Policies. Such exemptions are granted by the DOE to provide relief from requirements when sufficiently justified, in writing. "Shall" statements are requirements which must be implemented and many of these throughout this Manual are reflective of 10 CFR 835 requirements.

3. No individual shall willfully take or cause to be taken any action inconsistent with the requirements of this Manual.

4. Potential violations of the regulations or of the commitments made in the Radiation Protection Program shall be brought to the attention of the Chief Safety Officer or the SRSO in a timely manner. The SRSO shall coordinate the assessment of such potential violations through the designated Price Anderson Amendments Act (PAAA) Coordinators (see Articles 131.2e. and 135, *PAAA Program Implementation*). All non-compliances will be reported in accordance with the requirements of 10 CFR 820, *Procedural Rules for DOE Nuclear Activities* and applicable guidance and FESHM Chapters.

5. In the ever-changing conditions of a research environment, circumstances may arise when the specific requirements of this Manual cannot be met. Such circumstances may involve departures from accepted Laboratory procedures. Procedures for addressing such circumstances are stated in FESHM Chapter 1010, *Laboratory Environment, Health and Safety Management System and its Implementation* and vary dependent upon the approval authority involved (e.g., Laboratory, DOE, or outside regulatory body).

6. Nothing in this Manual shall be construed as limiting actions that may be necessary to protect the health and safety of the individuals employed here, users of Fermilab facilities, or members of the public consistent with the FESHM or good practice.

PART 2 RADIOLOGICAL PERFORMANCE

121 Radiological Performance Measures

Performance measures, including notable outcomes, shall be established as specified by the current contract between DOE and the FRA.

122 Assessments

Assessment, as used in this Manual, refers to the process of providing independent feedback to senior line managers to indicate the adequacy of the Radiological Control Program.

1. Inspections, audits, reviews, investigations and self-assessments are part of the numerous checks and balances needed in a good radiological control program. Internal audits of the Radiological Control Program shall be conducted such that over a 36 month period, all functional elements are assessed for program performance, applicability, content and implementation. A 30-day grace period may be allowed to accommodate the operation schedule.

2. The Fermilab Environment Safety and Health (ES&H) Self-Assessment Program (FESHM Chapter 1010.1) describes criteria for the conduct of self-assessments in all areas of environment, safety and health including radiological control.

123 Workplace Awareness

The management of Fermilab encourages the individual employees, users, and subcontractors to communicate all problems of environment, safety and health to management. The individual employees, users, and subcontractors are encouraged to continuously evaluate conditions and make suggestions that might serve to improve performance in this important program of the Laboratory. Employees having concerns about radiological activities are encouraged to contact their supervisor. Subcontractor employees and scientific users are encouraged to contact their Fermilab point-of-contact. If not satisfied, they may follow procedures outlined in FESHM Chapter 1060, *Fermilab ES&H Concerns Program*. Pertinent information on radiological control issues is provided to appropriate personnel through the Laboratory's Incident Investigation Program (FESHM Chapter 3020, *Incident Investigation and Analysis*) and, when general distribution is appropriate, through articles in the employee electronic newsletter *Fermilab Today*. Radiological control program issues and non-compliances are reported to DOE as specified in Article 135, Radiations Safety Subcommittee (RSSC) of the Fermilab ES&H Committee (FESHCom).

PART 3 FERMILAB RADIOLOGICAL CONTROL ORGANIZATION

General radiological and conventional ES&H organization and responsibilities are described in FESHM Chapter 11001, *Radiation Safety Program* that also serves to include this FRCM as part of FESHM. Since management of radiological processes often requires specialized training and controls, responsibilities of the radiological control component of this organization are described here in more detail. Individuals responsible for developing and implementing measures necessary for ensuring compliance with the requirements of this Manual shall have the education, training, and skills appropriate to discharge these responsibilities.

The Director holds overall responsibility for radiation safety and compliance with all applicable laws and regulations, and has appointed the Chief Safety Officer to lead the Laboratory in all areas of ES&H, and quality. The Chief Safety Officer shall serve the role of Senior Radiation Safety Officer (SRSO) or appoint a senior staff member to that position. The SRSO is the Radiological Control Manager for Fermilab. The SRSO advises the Chief Safety Officer and other senior management officials as appropriate in generating and promulgating radiation safety policy. The Director has assigned to each division/section/center head the responsibility of implementing the Radiological Control Program in their areas. In consultation with division/section/center heads, the SRSO, with input from others as appropriate, shall appoint Radiation Safety Officers (RSOs) to address radiation safety matters throughout the Laboratory. RSOs in the Accelerator Division may have extensive and direct roles in accelerator operations defined by Fermilab policies and Accelerator Division protocols. These roles, responsibilities and authorities are described more fully below.

131 Responsibilities

General ES&H responsibilities of individuals and the tenant/landlord relationship are described in FESHM Chapter 1010. These concepts apply to the Radiological Control Program as well. This section describes responsibilities in addition to the general responsibilities.

1. The Director:

    a. Is responsible for the Radiological Control Program.

    b. Shall appoint a Chief Safety Officer.

    c. Shall assign responsibility for maintaining the Radiological Control Program to the Environment, Safety, Health, and Quality Section (ESH&Q).

2. The Chief Safety Officer:

a. Shall appoint a SRSO who meets the qualification of Article 132, *Fermilab SRSO Qualifications*:

b. Shall ensure adherence to this Fermilab Radiological Control Manual.

c. Shall represent the Director in all matters of radiation safety.

d. Shall inform the Director of any serious violations of the FRCM, the regulations or of the commitments made in the Fermilab Radiation Protection Program.

e. Shall designate PAAA Coordinators as specified in FESHM Chapter 3030, *Noncompliance Tracking System*. The co-PAAA Coordinator for radiological matters is responsible for assessing and reporting violations of the regulations or of the commitments made in the Fermilab Radiation Protection Program in accordance with the requirements of 10 CFR 820. (See also Article 114.4.)

3. The SRSO:

a. Shall perform frequent periodic reviews of the Radiological Control Program.

b. As supported by the Chief Safety Officer shall arrange for sufficient staffing to assist divisions/sections/centers in carrying out the requirements of this FRCM.

c. Shall develop accelerator radiation standards in conjunction with appropriate division/section/center heads and the Director (see Chapters 2, *Radiological Standards*, 8, *Accelerator Shielding and Radioactivation* and 10, *Radiation Safety Interlock Systems*).

d. Shall acquire, distribute, maintain and calibrate radiation monitoring equipment (see Chapter 5, *Radiological Health Support Operations*).

e. Shall provide external and internal radiation dosimetry services (see Chapter 5).

f. Shall review designs of accelerator radiation safety interlock systems (see Chapter 10).

g. Shall assure proper maintenance of radiological protection records as specified elsewhere in this Manual and Fermilab policies on records management and document control.

h. Shall procure sealed radioactive sources and implement and maintain radioactive sources and nuclear materials control and accountability programs (see Chapter 4, *Radioactive Materials* Part 3, *Radioactive Source Controls*).

i. Shall supervise shipments of radioactive materials entering or leaving the Fermilab site (see Chapter 4), maintaining documentation in accordance with the provisions of the FESHM inclusive of this FRCM.

j. Shall implement a performance measures program as specified in accordance with Article 121, *Radiological Performance Measures*.

k. Shall lead the implementation of the Laboratory's program for maintaining radiation exposures as low as reasonably achievable ALARA.

l. Shall review the radiation protection aspects of new facilities or significant modifications to existing facilities. This shall include such issues as shielding, residual activation in beam enclosures, soil and groundwater activation, the production of airborne radioactivity, and operational controls, as applicable. It shall also include the management of dismantling operations, and where appropriate the recycling of materials such as metals.

m. Shall appoint RSOs in writing using Radiation Physics Form No. 14, *Evaluations of Qualifications of RSOs*. RSO qualifications shall be documented on an individual basis in detail and may include some or all of the following elements:

   1) Academic credentials in science or engineering appropriate to work in radiation protection.

   2) Certification by the American Board of Health Physics.

   3) Prior occupational experience in radiation protection.

   4) Successful completion of a training program established by the ESH&Q. The training program is to encompass the breadth of topics in radiation protection to be encountered at Fermilab as part of the assigned duties of the individual.

n. Will foster an active program for the development and refinement of radiation detectors, dosimetry systems and measurement methods, and accelerator shielding methodology.

4. Division/Section/Center Heads:

   a. Shall be responsible for maintaining elements of the Radiation Protection Program within the division/section/center.

   b. Shall clearly establish the roles, responsibilities and authorities of division/section/center personnel within the framework of this Manual.

   c. Shall ensure adherence to the FRCM.

   d. Shall inform the Director and the Chief Safety Officer or the SRSO of any serious violations of the FRCM in a timely manner.

   e. As applicable, shall ensure that beamline and experiment operating parameters are within the bounds specified by the appropriate Safety Assessment Document(s) (see FESHM Chapter 2010, *Planning and Review of Accelerator Facilities and Their Operations)*.

   f. As applicable, shall maintain records of beamline intensity and radiation measurements as requested by the SRSO. Record controls and retention shall meet the requirements in Chapters 5 and 7, *Radiological Records* of this Manual.

   g. As applicable, shall implement a program for proper control and characterization of radioactive waste generated within their division/section/center. This program shall be consistent with Laboratory policy as expressed in the FESHM inclusive of this FRCM, and DOE and disposal site protocols.

   h. Support, within financial, operational, and other management constraints, opportunities for continuing training of radiation protection staff within the division/section/center commensurate with their duties.

5. Radiation Safety Officers

   a. Shall lead efforts of one or more division/section/center heads in all matters of radiological control within a specified scope of activities assigned by the SRSO. Specific responsibilities may be delegated to other radiation protection personnel as required.

b. Shall coordinate assigned activity with other radiation protection efforts as needed..

c. May consult with the Chief Safety Officer and/or the SRSO on any concerns regarding a given activity within the divisions/sections/centers.

d. Shall supervise the radiological control activities of the designated radiation protection professional staff and, where applicable, the radiological control activities of designated Radiological Control Technicians (RCTs).

6. Radiation Protection Staff

Shall carry out the radiation protection program of the division/section/center under the direction of the RSO or the SRSO as applicable.

132 Fermilab Senior Radiation Safety Officer Qualifications

1. The SRSO serves as Radiological Control Manager at Fermilab. This individual should be an experienced professional in environment, safety and health and be familiar with the general design features and operations of the facility that affect the potential for exposures of individuals to radiation.

2. The SRSO should have the technical competence and experience to establish radiological control programs and the supervisory capability to direct the implementation and maintenance of radiological control programs.

3. The SRSO should have a minimum of a bachelor's degree or the equivalent in science or engineering, including general familiarity with radiological control. Advanced academic degrees**,** experience**,** certification by the American Board of Health Physics, and formal training related to radiological control may be considered as part of these qualifications.

133 Radiological Control Organization Functions and Staffing

1. All members of the Fermilab staff who primarily work in radiation protection topics are considered to comprise the Radiological Control Organization. The staff of the Radiological Control Organization includes health physicists and other professionals with four-year degrees in science or engineering as well as designated Radiological Control Technicians (RCTs) and technical personnel associated with maintaining radiation safety instrumentation.

2. For professional staff, advanced degrees in physics or engineering are highly encouraged. A continuing training program should be established by supporting

attendance at professional and DOE-sponsored meetings, academic qualification, continuing education courses, professional development courses, etc. Pursuit of certification by the American Board of Health Physics for professional staff members is encouraged.

3. For RCTs and personnel associated with developing and maintaining radiation safety instrumentation, continuing training and education is highly encouraged. Specific requirements discussed in Chapter 6, *Training and Qualification,* of the manual apply to RCTs. These personnel should have technical qualifications pertinent to their assigned responsibilities.

134 Radiation Safety Subcommittee of the Fermilab Environment, Safety and Health Committee

The RSSC, commissioned by the Laboratory Director, is responsible for coordinating the implementation and improvement of the FRCM. The RSSC reports to the Laboratory Director through the Chair of the Fermilab ES&H Committee (FESHCom). The RSSC meets to discuss both occupational and environmental radiation protection issues and develop solutions that will promote compliance and uniform implementation lab wide. The RSSC serves as Fermilab's ALARA Committee. RSSC meetings are documented through meeting minutes.

The official charter is maintained along with all other FESHCom subcommittee charters on the FESH Com website at: http://esh.fnal.gov/xms/Resources/FESHCom.

Fermilab's ALARA program is described in detail in Chapter 3, *Conduct of Radiological Work*, Part 5, *Fermilab ALARA Program*.

135 Price Anderson Amendments Act (PAAA) Program Implementation

The purpose of this article is to describe the Price Anderson Amendments Act (PAAA) Noncompliance Reporting program (see Article 114.4). Radiological issues and potential noncompliances with the Radiation Protection Program (see Article 112, *Radiation Protection Program*) are identified and evaluated through an interdisciplinary approach in accordance with principles of the Fermilab Integrated Safety Management Plan as implemented in the FESHM, including the FRCM. Overall responsibilities for PAAA program implementation, including the use of the DOE Noncompliance Tracking System (NTS), are set forth in FESHM Chapter 3030. This specifically includes coordination of reports required under the DOE Occurrence Reporting System described in FESHM Chapter 3010, *Significant and Reportable Occurrences,* with those submitted under NTS.

1. The co-PAAA Coordinator for radiological matters employs a number of venues and methods to identify opportunities for improvement in the Fermilab RPP and evaluate them for possible compliance issues. Prominent among these are the following:

    a. Discussions at regular meetings of Laboratory Management, ES&H professionals, FESH Com and its subcommittees including the RSSC, and the Management Team of the ESH&Q Section,

    b. Notifications of events and issues as they arise by laboratory management, professional ES&H staff lab-wide, and other concerned individuals, including reports received through the Laboratory's Employee Concerns Program,

    c. Observations made by members of the DOE-Fermi Site Office (DOE-FSO) and other DOE officials and related follow-up activities of Radiological Control Organization staff,

    d. Reviews of occurrences and programmatic issues identified at other facilities,

    e. Results of formal assessments and reviews of iTrack (management issues tracking database) entries.

2. DOE has established the NTS. This system is to be used by the PAAA Coordinators or alternate for the submission and tracking of potential regulatory noncompliances exceeding thresholds specified by DOE. Potential noncompliances beneath those thresholds may be tracked by an internal system designated by the contractor.

3. Potential radiological noncompliances exemplified by those that meet one or more of the following criteria shall be entered into iTrack, with the relevant specific 10 CFR 835 citation to facilitate subsequent trending;

    a. Issues identified by means of formal audits that are not routine monitoring and inspection activities of the Radiological Control Organization,

    b. Repetitive issues identified during formal or informal audits and reviews, even minor ones, that could possibly be indicative of systematic, rather than isolated failure to properly implement the RPP,

    c. Minor issues other than those found and corrected during routine monitoring and inspections of potential noncompliance that cannot be resolved in a short period of time (a radiological posting having fallen off of a door is an example),

d. Issues that may plausibly lead to other, perhaps more significant, noncompliances (a missing sign needed to post the entrance to a high radiation area might be an example),

e. Noncompliances that potentially involve more than one division, section, or center.

f. Situations involving radiological work or radiological conditions that result in a "Stop Work" condition as described in Articles 348, *Radiological Stop Work Authority* and 352.6.b or that are reported to the SRSO in accordance with Article 352.8.d.

g. Noncompliances identified by external organizations.

4. Potential noncompliances which, after screening, meet the criteria established by DOE for submission to its NTS will be entered into the NTS system and tracked through resolution by a co-PAAA Coordinator or alternate after review by senior Laboratory management and consultation with the DOE-FSO. A co-PAAA Coordinator will consult with the Senior Radiation Safety Officer and other ESH&Q Section staff to identify and implement additional reporting of radiological events under the DOE Occurrence Reporting System (see FESHM Chapter 3010) and to any external agencies under applicable requirements and regulations.

5. On an as-needed basis, a co-PAAA Coordinator will provide orientation on the PAAA reporting system and enforcement procedures to senior management staff and Radiological Control Organization personnel.

PART 4 DOE MANAGEMENT

141 DOE Employees on the Fermilab Site

DOE employees working at or visiting the Fermilab site are subject to and shall adhere to the provisions of this Manual.